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ABSTRACT

This was a study to see whether students learn specific material better in classes which emphasize recitation on fact questions or recitation which involves the students in higher cognitive reasoning and interpreting skills. A series of 10 one-hour ecology lessons were taught by specially trained teachers; the same curriculum materials were presented to four treatments groups. In one treatment group, teachers asked questions divided into 25 percent higher cognitive questions (HCQ's) and 75 percnet fact questions. Group 2 asked 50 percent of each kind of question. Group 3 used 75 percent HCQ's and 25 percent fact questions. Group 4 used no recitation, but involved the students in art activities on ecological themes. Students were examined before and after the course with tests that included multiple-choice, essay, and oral questions. Results are not to be generalized too broadly because recitation groups were unusually small (6 students) and teachers were taught to present rigid recitation plans. Results showed however, that the students in the 25 percent HCQ sample did slightly better on fact questions and about as well on reasoning questions as students in other groups. This indicated that having students recite facts may prompt their learning more effectively than has been supposed recently. The 50 percent HCQ sample did relatively poorly on facts, but out-performed the other groups on cognitive questions. The art group did not excel in either kind of test. (CD)

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Effects of Teaching by Recitation on Learning

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INTRODUCTION

This is a report of an experiment which was done to determine what student learning outcomes are affected by variations in teachers' use of higher cognitive questions in classroom recitations.[3] The classification of a question as "higher cognitive" was based on two criteria derived from Bloom's taxonomy of educational objectives in the cognitive domain (Bloom, 1956). First, a higher cognitive question requires the student to state predictions, solutions, explanations, evidence, generalizations, interpretations, or opinions. The second criterion is that the prediction, solution, etc. asked for in the question is not directly available in the curriculum materials; instead, the student is required to expand on or use in a new way information presented in the curriculum. Higher cognitive questions correspond to the Analysis, Synthesis, and Evaluation levels of Bloom's taxonomy. Questions which do not satisfy these requirements are classified as fact questions, corresponding to the Knowledge and Comprehension levels of Bloom's taxonomy.

The experiment was designed to test the belief of many educators (for example, Sanders, 1966) that teacher use of higher cognitive questions is important for developing students' ability to think. On this basis it was predicted that recitations with a high percentage of higher cognitive questions would promote more learning than recitations with a low percentage of these questions.

Another purpose of the experiment was to determine the effects of presence versus absence of recitations on student learning.

Review of Literature

The correlational studies relating cognitive levels of teachers' questions to student learning were reviewed by Rosenshine (1971), who concluded that "no clear relationship has been found between the frequency with which the teacher uses certain types of questions and the achievement of pupils..." (page 125). Further review and analysis by Heath and Nielsen (1975) indicates that the findings of these and similar studies are difficult to interpret because of flaws in research design. One problem is the limited range of student achievement measures which were used. For example, Wright and Nuthall (1970) found that the percentage of closed, that is, fact, questions was positively correlated (r=.46) with residual

student achievement scores, whereas the percentage of open, that is, higher cognitive, questions was negatively correlated (r=-.21) with the same criterion. The measure of student achievement was a multiple-choice fact recall test, which probably is appropriate for measuring the effects of fact questions but not of higher cognitive questions. This problem is handled within the experiment reported here by including tests designed specifically to measure higher cognitive learning outcomes.

Winne (1975) reviewed twelve experimental studies of teacher questions and found that "nine of them probably could not speak validly to the degree of influence that teacher questions have on student achievement." One of the three studies which were methodologically sound (Buggey, 1971) found that higher cognitive questions lead to improved achievement relative to lower cognitive questions for second graders. However, this finding was not replicated by Savage (1972) in his experiment using fifth grade students. The third methodologically sound study, by Tyler (1971), found that questions framed by teachers are more effective than questions presented in text for second graders.

The results of previous research on teachers' higher cognitive questions are not conclusive. The main implication of the review of literature is that further research characterized by rigorous methodology is needed.

METHOD

Treatments

The common basis for the four experimental treatments was a specially designed ecology curriculum. The curriculum included ten lessons, each requiring an hour of class time, and taught at the rate of one per day.

The curriculum materials were provided to all students, irrespective of treatment assignment, at the beginning of the class hour. The objectives of the curriculum were to provide students with information and ideas concerning balances that exist in nature; man's contribution to imbalances and to environmental pollution; and solutions to correct imbalances and pollution. The materials included a learning game, a film, two filmstrips, and text material for each lesson.

Following viewing and/or reading of materials at the start of each lesson, students formed into their assigned treatment groups. The four treatments are as follows:

25% HCQ (Higher Cognitive Questions) Treatment. Specially trained ecology teachers[4] conducted nine "semi-programmed" recitations, one for each of nine lessons. The recitations were programmed, that is, scripted in advance by the researchers, to insure uniformity of treatment across ecology teachers and to equate the opportunity to learn the curriculum content across treatment groups. Each recitation in each treatment consisted of sixteen questions. In the 25% HCQ treatment the recitations consisted of twelve fact questions and four higher cognitive questions. The questions pertained to the curriculum content which was included in the day's lesson. The ecology teachers probed and redirected students' answers to most of the questions. Since appropriate use of probing and

redirection techniques depends upon students' initial response to a question, this aspect of the recitations could not be scripted precisely (hence, "semi-programmed"). Instead, the ecology teachers were given guidelines concerning when and how often to use each technique.

50% HCQ Treatment. In this treatment the recitations consisted of eight fact questions and eight higher cognitive questions. The eight fact questions were selected from the set of twelve fact questions in the 25% HCQ treatment. The four higher cognitive questions of the 25% HCQ treatment also appeared in the 50% HCQ treatment, plus an additional four higher cognitive questions.

75% HCQ Treatment. In this treatment the recitations consisted of four fact questions and twelve higher cognitive questions. The four fact questions and eight of the twelve higher cognitive questions were selected from the 50% HCQ treatment.

Art Activity Treatment. The students in this treatment participated in nine sessions of ecology-related art activities. The ecology teachers were instructed not to ask any curriculum-related questions.

Fidelity of Treatment

Audiotapes of the three recitation treatments were made for two different lessons. Analysis of the audiotapes indicated high fidelity of treatment, that is, close correspondence between the recitation scripts and the teachers' actual behavior. Live observations of the Art Activity lessons indicated that the ecology teachers adhered closely to the requirements of this treatment.

Experimental Design

The four treatments--25% HCQ, 50% HCQ, 75% HCQ, and Art Activity--were manipulated in a latin square design. The complete design is shown in Table 1. Multi-stage randomization procedures were used to assign schools and sixth-grade classrooms to latin square blocks, teachers to latin square blocks, treatments to teachers, and students to treatments. Basically, this procedure resulted in twelve replications of each treatment. Each replication involved a group of students from a different classroom and a different ecology teacher. Each recitation group consisted of six students in order to make the recitation treatments comparable to another experiment being conducted by the researchers. Since there were three recitation groups in each classroom, a total of eighteen students were involved in recitation treatments. The remaining students in the classroom were assigned to the Art Activity treatment.

MEASURES[5]

Outcome measures were administered immediately before (pre), immediately after (post), or two weeks after (delayed) the treatments.

Verbal Ability. Student's scores of verbal ability from the Comprehensive Tests of Basic Skills (CTBS, Form Q-Level 2) were made available by the participating school districts. Where appropriate, these scores were used to adjust students' post and/or delayed scores on the other outcome measures.

Information Test. This multiple-choice test was administered three times to each

TABLE 1

Results of Assignment Procedures

BLOCK 1

ECOLOGY TEACHER	SCHOOL 1		SCHOOL 2	
	9AM* Class 1	10:00AM Class 2	12:30PM Class 3	2:00PM Class 4
8	Treatment 1 B=3 G=3	Treatment 3 B=3 G=3	Treatment 4 B=5 G=6	Treatment 2 B=3 G=3
7	Treatment 3 B=3 G=3	Treatment 2 B=3 G=3	Treatment 1 B=3 G=3	Treatment 4 B=5 G=4
10	Treatment 4 B=2 G-11	Treatment 1 B=3 G=3	Treatment 2 B=3 G=3	Treatment 3 B=3 G=3
12	Treatment 2 B=3 G=3	Treatment 4 B=6 G=9	Treatment 3 B=3 G=3	Treatment 1 B=3 G=3

BLOCK 2

ECOLOGY TEACHER	SCHOOL 3		SCHOOL 4	
	9:00AM Class 5	10:00AM Class 6	12:30PM Class 7	2:00 PM Class 8
4	Treatment 1 B=3 G=3	Treatment 3 B=3 G=3	Treatment 2 B=3 G=3	Treatment 4 B=8 G=7
11	Treatment 3 B=3 G=3	Treatment 2 B=3 G=3	Treatment 4 B=8 G=7	Treatment 1 B=3 G=3
1	Treatment 4 B=6 G=6	Treatment 1 B=3 G=3	Treatment 3 B=3 G=3	Treatment 2 B=3 G=3
5	Treatment 2 B=3 G=3	Treatment 4 B=3 G=7	Treatment 1 B=3 G=3	Treatment 3 B=3 G=3

BLOCK 3

ECOLOGY TEACHER	SCHOOL 5		SCHOOL 6	
	9:00AM Class 9	10:00AM Class 10	12:30PM Class 11	2:00PM Class 12
6	Treatment 1 B=3 G=3	Treatment 4 B=3 G=3	Treatment 4 B=7 G=7	Treatment 2 B=3 G=3
2	Treatment 3 B=3 G=3	Treatment 2 B=3 G=3	Treatment 1 B=3 G=3	Treatment 4 B=6 G=8
3	Treatment 2 B=3 G=3	Treatment 4 B=6 G=7	Treatment 4 B=3 G=3	Treatment 1 B=3 G=3
9	Treatment 4 B=7 G=7	Treatment 1 B=3 G=3	Treatment 2 B=3 G=3	Treatment 4 B=3 G=3

*Times are approximate.

Treatment 1 = 25% Higher Cognitive Questions
Treatment 2 = 50% Higher Cognitive Questions
Treatment 3 = 75% Higher Cognitive Questions
Treatment 4 = Art Activity II
B = Boys
G = Girls

student: pre, post, and delayed. It was designed to measure students' acquisition of factual information in the ecology curriculum. The test consists of three subscales to measure intentional and incidental learning. Intentional Scale II contains eight items measuring students' ability to recall information covered in the recitation treatments. The 25% HCQ Incidental Scale II consists of seven items which were intentional only for students in the 25% HCQ treatments; the items were incidental for students in the other treatments. Incidental Scale II consists of ten items testing recall of information presented in the curriculum materials but not in any of the treatment variations.

Oral Test. This individually administered test consists of six higher-cognitive questions which students answered orally. It was given pre and post treatment to all students, and was designed to measure students' ability to give plausible, reasoned oral responses to higher cognitive questions about the ecology curriculum. Since the nature of recitation is to elicit oral responses, it was thought that this test might be particularly sensitive to differences between the treatments in this experiment, for example, in the comparison of the recitation treatments with the Art Activity treatment. This test, like the Essay Test and Transfer Test described below, is scored on two scales: content (the number of plausible solutions, predictions, explanations, etc., in response to the question) and Logical Extension (the number of rationales and if...then extensions in response to the question).

Essay Test. This test, administered pre and post treatment, consists of twelve higher cognitive questions for which students are to write brief essay answers. Similar to the Oral Test, the content of the Essay Test questions refers to the ecology curriculum.

Transfer Test. This test, administered two weeks after completion of the treatments, consists of nine higher-cognitive questions for which students are to write brief essay answers. The purpose of this test was to determine whether higher cognitive response skills learned in the treatments would transfer to a new, unstudied curriculum topic--the problem of human population explosion.

Word Association Scale. This set of scales, administered pre and post treatment, was developed to measure students' attitudes toward the major ecological topics taught in the ecology curriculum. The measure consists of six semantic differential scales, each measuring students' attitudes toward a specific ecological topic through the use of ten bi-polar adjectives from Osgood's evaluative factor.

Gall-Crown Discussion Attitude Scale. This measure, administered pre and delayed treatment, consists of two Likert-type subscales: one of nineteen items measuring students' attitude toward class discussions and one of eleven items measuring students' attitudes toward teacher use of higher cognitive questions.

RESULTS

Data Analysis Plan

The data in the latin square design were examined by analysis of variance methods. Each of the main factors--recitation treatment, classrooms, teachers, and squares--was considered as a fixed effect in partitioning the total variance into main

effects for treatments, classroom within squares, teachers within squares, squares, a treatment by square interaction, and a residual (error) term. Since the unit of analysis was the treatment group mean, the within group variance could not be used to provide an error term. The residual term was a pooled estimate of between group variance composed of all the possible interaction terms except the estimable treatment by square interaction.

In addition to examining the data for overall treatment differences, several a priori questions pertaining to differences between treatment groups were of interest. The following planned comparisons of treatment differences were examined: (a) 25% HCQ versus 50% HCQ; (b) 50% HCQ versus 75% HCQ; (c) 25% HCQ versus 75% HCQ; and (d) the recitation treatments as a whole versus Art Activity.

Each dependent variable was examined for the possibility of adjusting for pre-experimental differences before performing the analyses of variance. Dependent variables were adjusted when the correlation between the variable to be adjusted and the adjusting variable was greater than .30 and the usual assumptions for analysis of covariance were satisfied (Elashoff, 1969).

Presentation of Findings

The results of all of the data analyses are summarized in Table 2 (measures of ability, achievement, and attendance[6]) and Table 3 (attitude scales).

The leftmost column lists the names of the dependent variables. Each row of the table corresponding to the variable named presents information pertaining to that variable only.

If the dependent variable was adjusted before the data were analyzed, the name of the adjusting variable appears in the column labeled "Adjusting Variable." The majority of the adjusting variables are the pretreatment measures corresponding to the dependent variable, signified as "pre." Otherwise total reading score was generally the adjusting variable.

The column labeled "MS error" presents the error mean square from the analysis of variance of cell means or adjusted cell means and its degree of freedom for each dependent variable.

The next five columns list the F-statistics computed for the main effect of treatment, of class within squares, of teachers within squares, of squares and the treatment by square interaction, respectively. Also noted are the degrees of freedom associated with each effect. The critical value of the F-statistic at the five percent level of significance is presented in the footnote. F-statistics for dependent variables which are greater than the critical value are starred within the column to note statistical significance. The columns show the strength of association statistics associated with the column's treatment effect. This statistic is interpreted as the percentage of variance in the dependent variable attributable to the treatment effect for that column.

The next four columns present cell means for each treatment condition in the latin square design, that is, 25% HCQ, 50% HCQ, 75% HCQ, and Art Activity, respectively. For those variables which were adjusted before entry into the analysis of variance, these values are adjusted cell means. A reference number in parentheses associated with each treatment is used in labeling the columns for planned comparisons.

TABLE 2

Analysis of Variance Summary for
Measures of Ability, Achievement, and Attendance

DEPENDENT VARIABLE	ADJUSTING VARIABLE	MS_{error} df=18	F VALUES AND ω^2 FOR ANALYSIS OF VARIANCE EFFECTS										TREATMENT MEANS				PLANNED COMPARISONS				
			Treatment		Class		Teacher		Square		Treatment by Square		25%HCQ Treatment	50%HCQ Treatment	75%HCQ Treatment	Art Activ. II	Treatments 1 vs 2	Treatments 2 vs 3	Treatments 1 vs 3	Treatments 1,2,3 vs 4	
			$F_{3,18}$	ω^2	$F_{9,18}$	ω^2	$F_{9,18}$	ω^2	$F_{4,18}$	ω^2	$F_{6,18}$	ω^2	(1)	(2)	(3)	(4)	$F_{1,18}$	$F_{1,18}$	$F_{1,18}$	$F_{1,18}$	Prop.
Number of Sessions Attended		0.51	0.18	0.00[a]	0.46	0.00	0.96	0.00	1.49	0.02	1.11	0.01	9.23	9.04	9.17	9.21	0.45	0.19	0.06	0.07	0.13[b]
CTBS[c] - Total Reading		48.25	0.53	0.00	1.38	0.02	0.82	0.00	0.93	0.00	1.01	0.00	61.69	64.71	61.85	63.63	1.13	1.10	0.00	0.14	0.09
Ecology Information Test:																					
Intentional Scale II, post		0.33	8.55*	0.31	1.42	0.05	1.08	0.01	0.72	0.00	0.69	0.00	6.27	5.94	6.29	5.26	2.01	2.21	0.00	22.83*	0.89
Intentional Scale II, delay	total rdng.	0.40	12.51*	0.42	0.77	0.00	0.92	0.00	3.85*	0.07	0.54	0.00	6.19	5.26	5.85	4.74	13.12*	5.31*	1.73	24.10*	0.48
25% Intentional Scale II, post	total rdng.	0.35	9.46*	0.40	1.00	0.00	0.54	0.00	0.48	0.00	0.28	0.00	4.68	3.53	4.01	3.62	22.96*	3.97	7.83*	5.21*	0.18
25% Intentional Scale II, delay	total rdng.	0.49	5.20*	0.25	0.75	0.04	0.42	0.00	0.54	0.00	0.73	0.00	4.52	3.56	3.76	3.56	11.59*	0.50	7.30*	2.67	0.47
Incidental Scale II, post	total rdng.	0.48	7.49*	0.27	1.60	0.07	0.88	0.00	2.37	0.04	1.57	0.05	5.97	4.92	5.83	5.00	13.66*	10.29*	0.24	6.34*	0.28
Incidental Scale II, delay	total rdng.	0.68	7.30*	0.28	1.37	0.05	0.49	0.00	1.86	0.03	0.90	0.00	5.91	4.52	5.34	4.67	17.22*	5.97*	2.91	4.49*	0.21
Oral Test:																					
Content, post	pre	1.10	5.53*	0.19	0.42	0.00	0.73	0.00	9.88*	0.25	2.12	0.15	8.88	8.83	8.42	7.35	0.01	0.95	1.17	15.15*	0.91
Logical Extension, post	pre	0.68	4.91*	0.13	3.49*	0.25	1.19	0.02	3.22	0.05	1.42	0.03	4.03	3.80	3.10	2.95	0.50	4.30	7.73*	6.39*	0.43
Essay Test:																					
Content, post	pre	1.19	8.15*	0.14	9.77*	0.52	1.35	0.02	1.57	0.01	0.97	0.00	11.58	12.55	11.64	10.36	4.73*	4.11	0.02	18.54*	0.76
Logical Extension, post		0.71	1.18	0.01	2.49*	0.27	0.35	0.00	0.15	0.00	0.34	0.00	2.11	2.30	2.03	1.68	1.34	0.62	0.04	2.89	0.81
Transfer Test:																					
Content, delay	Ess. Cont.,pre	2.29	0.32	0.00	1.75	0.15	0.34	0.00	1.78	0.04	0.58	0.00	8.79	8.99	8.62	8.40	0.10	0.07	0.61	0.61	0.64
Logical Extension, delay		0.39	0.64	0.00	3.33*	0.32	1.24	0.03	1.03	0.00	0.38	0.00	1.67	1.73	1.85	1.51	0.07	0.22	0.53	1.37	0.72

*Significance at the .05 level. The .05 levels for F values with the following degrees of freedom are:
$F_{1,18} = 4.41$ $F_{2,18} = 3.55$ $F_{3,18} = 3.16$ $F_{6,18} = 2.66$ $F_{9,18} = 2.45$

[a] ω^2 = proportion of total variance explained (omega squared).

[b] Prop. = Sum of squares for Treatments 1,2,3 vs 4 as a proportion of total treatment sum of squares.

[c] CTBS = Comprehensive Tests of Basic Skills.

TABLE 3

Analysis of Variance Summary for Attitude Scales

DEPENDENT VARIABLE	ADJUSTING VARIABLE	MS_{error} df=18	F VALUES AND ω^2 FOR ANALYSIS OF VARIANCE EFFECTS										TREATMENT MEANS				PLANNED COMPARISONS				
			Treatment		Class		Teacher		Square		Treatment by Square		25% HCQ Treatment	50% HCQ Treatment	75% HCQ Treatment	Art Activ. II	Treatments 1 vs 2	Treatments 2 vs 3	Treatments 1 vs 3	Treatments 1,2,3 vs 4	
			$F_{3,18}$	ω^2	$F_{9,18}$	ω^2	$F_{9,18}$	ω^2	$F_{2,18}$	ω^2	$F_{6,18}$	ω^2	(1)	(2)	(3)	(4)	$F_{1,18}$	$F_{1,18}$	$F_{1,18}$	$F_{1,18}$	Prop.
Word Association Scale																					
Ecology																					
Balance of Nature		30.97	0.48	0.00	1.14	0.03	0.80	0.00	1.17	0.00	0.79	0.00	62.49	63.01	64.51	61.91	0.05	0.43	0.79	0.59	0.31[b]
Wolf		16.51	1.94	0.05	0.96	0.00	0.79	0.00	0.39	0.00	1.87	0.09	59.73	59.40	61.41	57.93	0.04	1.48	1.02	4.12*	0.71
Air Pollution	pre	10.13	6.33*	0.23	0.65	0.00	1.55	0.07	0.80	0.00	1.64	0.05	57.48	55.74	57.57	52.62	1.81	1.98	0.00	16.46*	0.87
Alligator		6.51	0.48	0.00	0.34	0.00	0.59	0.00	1.02	0.00	0.57	0.00	60.21	59.22	59.59	60.27	0.91	0.13	0.35	0.51	0.39
Water Pollution	pre	10.62	7.40*	0.27	1.84	0.10	0.65	0.00	0.19	0.00	0.81	0.00	51.65	49.42	54.61	46.86	2.82	5.72*	0.51	16.15*	0.73
		6.76	0.53	0.00	0.72	0.00	0.75	0.00	4.21*	0.12	1.44	0.05	59.91	58.59	59.07	59.15	1.55	0.21	0.62	0.00	0.00
Gall-Crown Dis. Attitude Scale:																					
Att. toward Thought Questions	pre	4.54	1.38	0.02	0.54	0.00	0.95	0.00	1.26	0.01	2.24	0.14	30.33	29.91	30.83	29.13	0.23	1.13	0.34	3.00	0.73
Attitude toward Discussion	pre	22.44	0.65	0.00	1.23	0.04	0.45	0.00	1.29	0.01	1.73	0.09	56.14	55.69	54.17	53.92	0.05	0.62	1.04	0.80	0.41

*Significance at the .05 level. The .05 levels for F values with the following degrees of freedom are:
$F_{1,18} = 4.41$ $F_{2,18} = 3.55$ $F_{3,18} = 3.16$ $F_{6,18} = 2.66$ $F_{9,18} = 2.45$

[a] ω^2 = proportion of total variance explained (omega squared).

[b] Prop. = Sum of squares for Treatments 1,2,3 vs 4 as a proportion of total treatment sum of squares.

The next four columns present F-statistics for the planned comparisons of treatment group means or adjusted means. The first of these columns compares 25% HCQ with 50% HCQ (1 vs. 2); the second contrasts 50% HCQ with 75% HCQ (2 vs. 3); the third contrasts 25% HCQ with 75% HCQ (1 vs. 3). The next column compares the average effect of the three recitation treatments with the nonrecitation Art Activity treatment. Each of these planned comparisons has one degree of freedom and was tested using the error mean square from the analysis of variance. The critical value of the F-statistic for 1 and 17 degrees of freedom at the 5 percent level of significance is provided. F-statistics which are statistically significant at the 5 percent level are starred. In the column labeled "Prop," the ratio of sum of squares for the contrast to sum of squares for the main effect of treatments is presented. This is a measure of the proportion of variability among the four treatments accounted for by the difference between the mean of the recitation treatments and the non-recitation treatment. In other words, this ratio indexes the degree to which recitation was the contributing factor in the main effect for treatments.

To assure that the results for various post and delay measures were not simply reflecting pre-existing differences among the sampled students, analyses of variance were performed on the total reading scores, i.e., the sum of vocabulary and comprehension subscale scores from the Comprehensive Tests of Basic Skills and on average number of lessons attended by students within a group. No effects significant at the 5 percent level were observed; the omega squared values were zero, with one exception. Similar results were obtained for number of sessions held. It seems reasonable to conclude that differential absenteeism is unlikely to have been influential in producing the results observed in this table.

Differences Between Recitation Treatments

The planned comparison of the recitation treatment means show that percentage of higher cognitive questions was a statistically significant influence on the amount of information acquired by students as measured by subscales on the Ecology Information Test. The pattern of treatment mean scores is depicted in Figure 1. It appears that a U curve describes the relation between percentage of higher cognitive questions and achievement on intentional and incidental scales of the Ecology Information Test. In all cases, the 50% HCQ treatment has considerably lower outcomes on the subscales of the Ecology Information Test than the other two discussion treatments. The 75% HCQ and 25% HCQ treatment outcomes fall at similar points for the various subtests. Outcomes for the art activity treatment approximate those for the 50% HCQ treatment.

The 25% HCQ treatment was superior to the other two recitation treatments on the 25% HCQ Intentional Scale II. This finding is predictable, in that students in the 25% HCQ treatment had the advantage of answering (intentional) items which were not covered in the recitations of students in the 50% HCQ and 75% HCQ treatments.

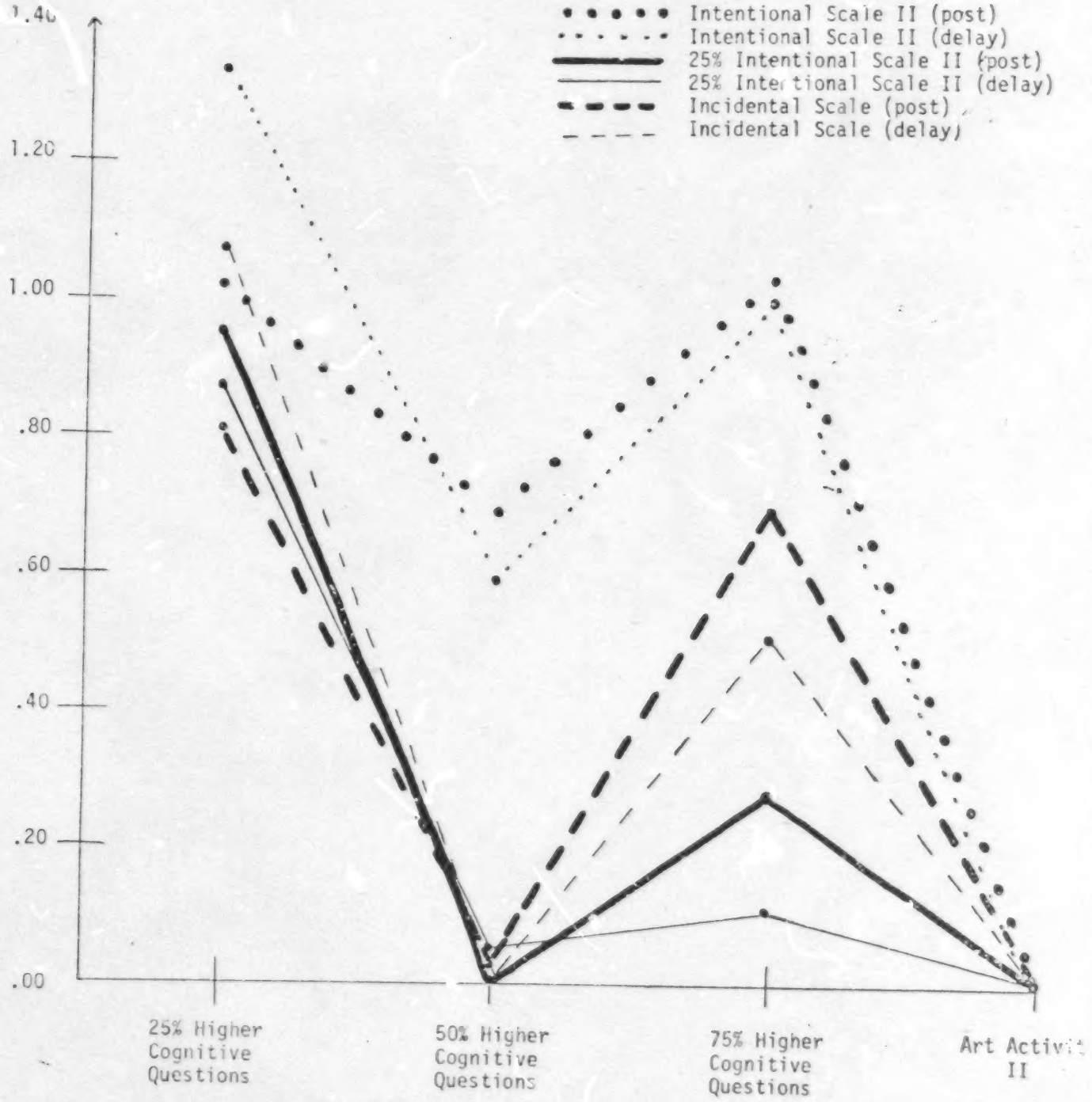
Two of the comparisons involving higher cognitive achievement measures were statistically significant. Students in the 50% HCQ treatment outperformed students in the 75% HCQ treatment on one of the Oral Test measures. They also outperformed students in the 25% HCQ treatment (statistically significant) and in the 75% HCQ treatment (approaching statistical significance) on one of the Essay Test measures.

The mean scores of the recitation treatments on the attitude scales were quite

FIGURE 1

Patterns of Treatment Differences for

Ecology Information Subtests



*Data points on the graph are based on unadjusted treatment means. The three recitation treatment means are expressed on the ordinate as absolute deviations from the art activity treatment means. The latter means serve as a baseline or zero value.

similar. Only one of the planned comparisons was statistically significant. Students in the 75% HCQ treatment expressed significantly more positive attitudes toward alligators than did students in the 50% HCQ treatment.

Recitation Treatments versus Art Activity

With one exception the mean scores of students in the combined recitation treatments were statistically greater than the mean scores of students in the Art Activity treatment on the Information Test measures. Also, the mean scores of students in the combined recitation treatments were statistically greater than the mean scores of students in the Art Activity treatments on three of the six higher cognitive achievement measures. The mean score of students in each recitation treatment was greater than the corresponding Art Activity treatment mean score for the three measures which did not reveal a statistically significant difference.

Planned comparisons involving the attitude measures revealed two significant differences. Students in the recitation treatments developed significantly more positive attitudes toward animals (wolves and alligators) presented in the curriculum than did students in the Art Activity treatment. Differences in scores on the other attitude scales, although not statistically significant, also generally favored the recitation treatments over the Art Activity treatment.

Other Effects

Very few of the other effects in the analysis of variance--class, teacher, square, and treatment by square--were statistically significant. Omega squared values were consistently small.

As intended, the main effects attributable to ecology teachers were negligible. This result probably reflects the training given to the ecology teachers in following prescribed instructional patterns for each of the treatments.

DISCUSSION

The generalizability of the findings is limited by the fact that the experimental recitations were not representative of typical classroom teaching in two important respects. First, unlike the usual whole-class discussion, the experimental recitations were conducted in small groups of only six students. Second, the ecology teachers taught from prescribed recitation plans developed by the researchers which were delivered in rigidly defined ways. Therefore, the results probably cannot be used to judge the effectiveness of the use of recitations by teachers in normal classrooms. In effect, the studies were designed to achieve high internal validity at the cost of limiting their generalizability.

Within these above constraints on generalizability, it can be said that variation in the percentage of higher cognitive questions in recitations does affect learning. However, the effects are puzzling. Relative to the 25% HCQ and 75% HCQ treatments, the 50% HCQ treatment was the least effective in promoting knowledge acquisition and retention, but it was the most effective in promoting higher cognitive performance. Since the recitations of the 50% HCQ treatment did not emphasize either fact or higher cognitive questions, it is possible that students were confused concerning the objective of the recitations--was the objective to

rehearse facts, or to think about them? To lessen their sense of confusion, some students may have decided to concentrate on answering teacher higher cognitive questions and ignored the fact questions, thereby causing a decrement in performance on the Information Test.

Generally students in the 25% HCQ treatment outperformed students in the 75% HCQ treatment both on the knowledge acquisition and higher cognitive measures, although the absolute differences between mean scores were small. Contrary to the belief held by many educators, this finding suggests that an emphasis on fact questions rather than on higher cognitive questions is the more desirable teaching pattern.

As expected, students in the 25% HCQ treatment answered correctly more of the Information Test items which were intentional for them, but incidental for students in the other two treatments. This finding suggests the generalization that if the teacher wants students to learn certain information in the curriculum, it is effective to rehearse that information by asking questions in recitation.

One purpose for conducting the experiment was to determine the effects of presence versus absence of recitations on student learning. The findings clearly show that presence of recitations does have a significant positive effect. Recitations following initial viewing and/or reading curriculum materials make a contribution to learning beyond that produced by the initial viewing-reading experience. Specifically, recitations improve acquisition and retention of information and the ability to respond in written or oral form to higher-cognitive questions. Also, there is some evidence, although not as strong as for the above learning outcomes, that recitations can promote the development of positive attitudes toward the curriculum content.

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FOOTNOTES

[1] The senior author is now affiliated with the University of Oregon, College of Education, Eugene, Oregon.

[2] Dr. Philip Winne is now affiliated with Simon Fraser University, Faculty of Education, Burnaby, B.C., Canada.

[3] This report is a summary of a larger report on this and another experiment. The other experiment used the same research design, teachers and curriculum as in this study. The treatments were different, though, because the experiment was designed to investigate the effects of teacher use of the recitation techniques of probing (asking the student a "follow-up" question to improve his initial answer) and redirection (calling on more than one student to respond to a question). Another purpose of the experiment was to study the effects of teachers' questions delivered in recitation compared with the same questions presented and answered in written format. Three supplemental volumes present copies of the measures, curriculum and recitation materials, and item statistics. Requests for the full report and supplemental volumes should be sent to: Dr. Beatrice A. Ward, Far West Laboratory for Educational Research and Development, 1855 Folsom Street, San Francisco, CA 94103.

[4] The specially trained teachers are called "ecology teachers" in the report. These teachers were selected from substitute teacher rolls and trained by the researchers to conduct the treatments. The students' regular teacher did not participate in the experiment.

[5] Selected measures from the experiment are reported here. Measures of question-generating ability and attitudes toward the experimental conditions are described in the full report.

[6] The measure of attendance was the number of treatment sessions (possible range, 0 - 10) at which each student was present.